point (whichever is smaller), then a correction shall be made by either of the following two methods:

(i) Mechanically adjust the instrument so that it agrees with the calibration measurement at the specified flow rates using the criteria of paragraph (a)(6) of this section, or

(ii) Develop a continuous best fit calibration curve for the instrument (as a function of the calibration device flow measurement) from the calibration points to determine corrected flow. The points on the calibration curve relative to the calibration device measurements must be within ±1.0 percent of the maximum operating range of ±2.0 percent of the point (whichever is smaller).

(7) For double dilution systems, the accuracy of the secondary dilution flow measurement device should be within ±1.0 percent of the total flow through the filter.

(b) *Other systems.* A bell prover may be used to calibrate the instrument if the procedure outlined in ANSI B109.1–1973 is used. Prior approval by the Administrator is not required to use the bell prover.

[54 FR 14593, Apr. 11, 1989]

§ 86.1321–90 Hydrocarbon analyzer calibration.

The FID hydrocarbon analyzer shall receive the following initial and periodic calibration. The HFID used with petroleum-fueled diesel engines shall be operated to a set point ±10 °F (±5.5 °C) between 365 and 385 °F (185 and 197 °C). The HFID used with methanol-fueled engines shall be operated at 235±15 °F (113±8 °C).

(a) *Initial and periodic optimization of detector response.* Prior to introduction into service and at least annually thereafter, the FID hydrocarbon analyzer shall be adjusted for optimum hydrocarbon response.

(1) Follow good engineering practices for initial instrument start-up and basic operating adjustment using the appropriate fuel (see §86.1314) and zero-grade air.

(2) Optimize the FID's response on the most common operating range. The response is to be optimized with respect to fuel pressure or flow while meeting the analyzer response time

given in §86.1310(b)(3)(vii)(A) for continuous HC measurement. Efforts shall be made to minimize response variations to different hydrocarbon species that are expected to be in the exhaust. Good engineering judgement is to be used to trade off optimal FID response to propane-in-air against reductions in relative responses to other hydrocarbons. A good example of trading off response on propane for relative responses to other hydrocarbon species is given in Society of Automotive Engineers (SAE) Paper No. 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbon in Diluted Automotive Exhausts"; author Glenn D. Reschke. It is also required that the response be set to optimum condition with respect to air flow and sample flow. Heated Flame Ionization Detectors (HFIDs) must be at their specified operating temperature.

(3) One of the following procedures is to be used for FID or HFID optimization:

(i) Use the procedures outlined in Society of Automotive Engineers (SAE) paper No. 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbons in Diluted Automobile Exhaust"; author, Glenn D. Reschke, as an example.

(ii) The HFID optimization procedures outlined in 40 CFR part 86, subpart D, §86.331–79(c).

(iii) Alternative procedures may be used if approved in advance by the Administrator.

(iv) The procedures specified by the manufacturer of the FID or HFID.

(4) After the optimum fuel, air, and sample pressures or flow rates have been determined, they shall be recorded for future reference.

(b) *Initial and periodic calibration.* Prior to introduction into service and monthly thereafter, the FID or HFID hydrocarbon analyzer shall be calibrated on all normally used instrument ranges. Use the same flow rate and pressures as when analyzing samples. Calibration gases shall be introduced directly at the analyzer, unless the "overflow" calibration option of §86.1310(b)(3)(i) for the HFID is taken.

(1) Adjust analyzer to optimize performance.

(2) Zero the hydrocarbon analyzer with zero-grade air.

(3) Calibrate on each used operating range with a minimum of 6, approximately equally spaced, propane-in-air calibration gases (e.g., 15, 30, 45, 60, 75, and 90 percent of that range). For each range calibrated, if the deviation from a least-squares best-fit straight line is within ±2 percent of the value at each non-zero data point and within ±0.3 percent of full scale on the zero data point, then concentration values may be calculated by using the linear calibration equation for that range. If the deviation exceeds these limits, then the best-fit non-linear equation which represents the data within these limits shall be used to determine concentration values.

(c) *FID response factor to methanol.* When the FID analyzer is to be used for the analysis of hydrocarbon samples containing methanol, the methanol response factor of the analyzer shall be established. The methanol response factor shall be determined at several concentrations in the range of concentrations in the exhaust sample.

(1) The bag sample of methanol for analysis in the FID shall be prepared using the apparatus shown in Figure N90–10. A known volume of methanol is injected, using a microliter syringe, into the heated mixing zone (250 °F (121 °C)) of the apparatus. The methanol is vaporized and swept into the sample bag with a known volume of zero-grade air measured by a dry gas meter.
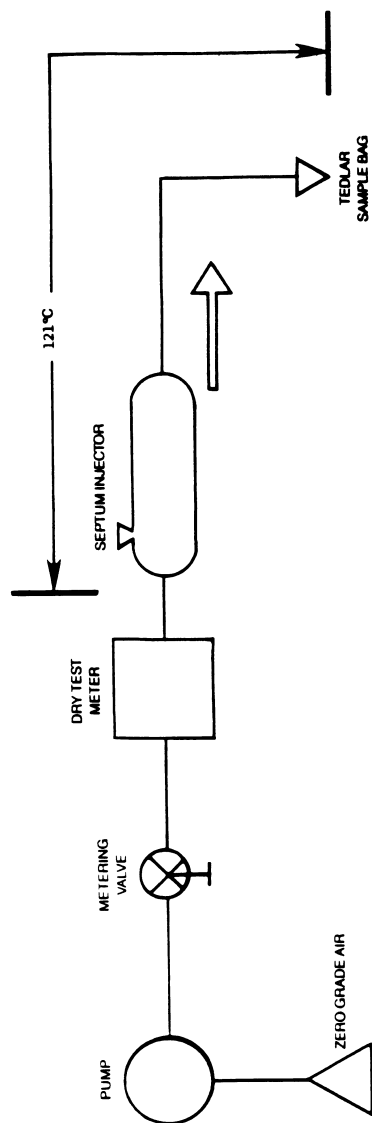
FIGURE N90-10 APPARATUS FOR PREPARATION OF FID METHANOL RESPONSE CALIBRATION MIX

(2) The bag sample is analyzed using the FID.

(3) The FID response factor, r, is calculated as follows:

r = FIDppm/SAMppm

Where:

(i) r = FID response factor.

(ii) FIDppm = FID reading in ppmC.

(iii) SAMppm = methanol concentration in the sample bag in ppmC.

$$= \frac{0.02406 \times \text{fuel injected} \times \text{fuel density}}{\text{Air volume} \times \text{mol. wt. CH}_3\text{OH}}$$

Where:

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(iv) 0.02406 = volume of one mole at 29.92 in Hg and 68 °F, m³.

(v) Fuel injected = volume of methanol injected, ml.

(vi) Fuel density = density of methanol, 0.7914 g/ml.

(vii) Air volume = volume of zero-grade air, m³.

(viii) Mol. Wt. CH₃OH = 32.04.

[54 FR 14594, Apr. 11, 1989, as amended at 62 FR 47128, Sept. 5, 1997]

§ 86.1321–94   Hydrocarbon analyzer calibration.

The FID hydrocarbon analyzer shall receive the following initial and periodic calibration. The HFID used with petroleum-fueled, natural gas-fueled and liquefied petroleum gas-fueled diesel engines shall be operated to a set point ±10 °F (±5.5 °C) between 365 and 385 °F (185 and 197 °C). The HFID used with methanol-fueled engines shall be operated at 235 ±15 °F (113 ±8 °C).

(a) *Initial and periodic optimization of detector response.* Prior to introduction into service and at least annually thereafter, the FID hydrocarbon analyzer shall be adjusted for optimum hydrocarbon response.

(1) Follow good engineering practices for initial instrument start-up and basic operating adjustment using the appropriate fuel (see § 86.1314) and zero-grade air.

(2) Optimize the FID's response on the most common operating range. The response is to be optimized with respect to fuel pressure or flow while meeting the analyzer response time given in § 86.1310(b)(3)(vii)(A) for continuous HC measurement. Efforts shall be made to minimize response variations to different hydrocarbon species that are expected to be in the exhaust. Good engineering judgement is to be used to trade off optimal FID response to propane-in-air against reductions in relative responses to other hydrocarbons. A good example of trading off response on propane for relative responses to other hydrocarbon species is given in Society of Automotive Engineers (SAE) Paper No. 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbon in Diluted Automotive Exhausts"; author Glenn D. Reschke. It is also required that the response be set to optimum

condition with respect to air flow and sample flow. Heated Flame Ionization Detectors (HFIDs) must be at their specified operating temperature.

(3) One of the following procedures is to be used for FID or HFID optimization:

(i) Use the procedures outlined in Society of Automotive Engineers (SAE) paper number 770141, "Optimization of Flame Ionization Detector for Determination of Hydrocarbons in Diluted Automobile Exhaust"; author, Glenn D. Reschke, as an example. Available from Society of Automotive Engineers International, 400 Commonwealth Dr., Warrendale, PA 15096–0001.

(ii) The procedure listed in subpart D, § 86.331–79(c) of this part.

(iii) The procedures specified by the manufacturer of the FID or HFID.

(iv) Alternative procedures may be used if approved in advance by the Administrator.

(4) After the optimum fuel, air and sample pressures or flow rates have been determined, they shall be recorded for future reference.

(b) *Initial and periodic calibration.* Prior to introduction into service and monthly thereafter, the FID or HFID hydrocarbon analyzer shall be calibrated on all normally used instrument ranges. Use the same flow rate and pressures as when analyzing samples. Calibration gases shall be introduced directly at the analyzer, unless the "overflow" calibration option of § 86.1310(b)(3)(i) for the HFID is taken.

(1) Adjust analyzer to optimize performance.

(2) Zero the hydrocarbon analyzer with zero-grade air.

(3) Calibrate on each used operating range with a minimum of 6, approximately equally spaced, propane-in-air calibration gases (e.g., 15, 30, 45, 60, 75, and 90 percent of that range). For each range calibrated, if the deviation from a least-squares best-fit straight line is within ±2 percent of the value at each non-zero data point and within ±0.3 percent of full scale on the zero data point, then concentration values may be calculated by using the linear calibration equation for that range. If the deviation exceeds these limits, then the best-fit non-linear equation which represents the data within these limits